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EDITORIAL DEPARTMENT NOTE

Priorities and allocations have affected some industries more than others. Those who have not as yet had experience with the regulation of raw material supply and finished product disposition for the most critical materials can profit by the experience of those who have operated under the most stringent regulations. The industrial accountant is concerned with priorities because of the records which must be kept and the reports which need to be rendered under priority regulations. In the first article in this issue of the *Bulletin*, Mr. Keller describes the accounting problems arising from priority control of cork, which is ranked second only to aluminum in scarcity of available stocks for other than defense needs.

I. Wayne Keller received his academic training at Elizabethtown College. Following his graduation with the B.S. degree in Economics in 1930, he joined the Armstrong Cork Company as a clerk. He was soon promoted to the General Office Cost Department, where he served until 1936, when he was made Sub-Controller of the Company's Pittsburgh Factory. In 1938 he became Chief Accountant for his Company. Mr. Keller has been active in the affairs of the Lancaster (formerly Reading) Chapter, and is at present serving as Chapter President.

When productive processes change, methods of costing must often be changed also, if logical and usable costs are to be obtained. Our second article is a good illustration of how methods of burden application can be changed to bring the cost figures into agreement with manufacturing methods.

The author of this method, Fred O. Kudert, received his education in Germany and at Northwestern University in Chicago. Coming to this country in 1922, he worked for one year as Time-study and Production Engineer for the Eisendrath Glove Co., and for eight years as Cost Accountant for Forte Brothers Gear & Machine Co., before joining the J. L. Clark Manufacturing Co. as Cost Accountant in 1931. Mr. Kudert has been active in the management of the Rockford Chapter, and last year served his Chapter as President.

Articles published in the *Bulletin* present many different viewpoints. In publishing them the Association is not sponsoring the views expressed, but is endeavoring to provide for its members material which will be helpful and stimulating. Constructive comments are welcomed and will be published in the Forum Section of the *Bulletin*.

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DECEMBER 1, 1941

ACCOUNTING PROBLEMS UNDER PRIORITY REGULATIONS OF PRODUCTION AND SALES

By I. Wayne Keller, Chief Accountant, Armstrong Cork Co., Lancaster, Pa.

ON MAY 26, 1941 all manufacturers of cork products received a telegram from the Priorities Division of the Office of Production Management ordering them to restrict their processing, until June 12, to 50 per cent of their average daily rate for the calendar month of April, 1941. The instructions of these telegrams were confirmed and elaborated in General Preference Order No. M-8, dated May 31, 1941; and a regulatory body was appointed to insure conformance to the order and to establish processing and delivery allotments for the future.

Almost overnight, the entire cork industry of the United States was placed under the control of the Priorities Division of the Office of Production Management. Since cork is rated second only to aluminum in scarcity of available stocks for other than defense needs, the regulations are of necessity stringent and detailed. Many other industries burdened with national interest have been regulated to an equal or lesser degree and it seems inevitable that many others will be similarly regulated as conditions become more acute. Those who have thus far not required rationing and those who have been affected to a lesser degree may well study the experiences of others and take such steps as they may deem desirable to cushion the impact of sudden and more stringent regulation. To this end, this paper briefly reviews such experience in operating under the regulations imposed upon the cork industry.

The Preference Order

The regulatory order states the need for regulation, definitions of terms, and its scope with the following sections having a direct bearing upon the records required:

"(c) On and after June 12, 1941, each such supplier is hereby directed to set aside his entire stock of cork and all finished and semi-finished products and materials of which cork is a component, as a reserve, for the fulfillment of present and future defense orders and such other orders and uses as may be au-

thorized, from time to time, by the Director of Priorities, from which reserve no deliveries or withdrawals shall be made either for customers of such supplier or for purposes of manufacture or processing by such supplier except pursuant to specific directions issued by the Director of Priorities.

"(d) Where there is doubt as to whether a particular contract or order is a defense order, before any action is taken thereon, the matter shall be referred to the Division of Priorities, with a statement of all pertinent known facts, for its determination.

"(e) All such suppliers shall maintain accurate and complete records and information concerning:

(1) Their inventories of raw materials, work in process, and finished stocks.
(2) All contracts and orders placed with them for cork and products and materials of which cork is a component, setting forth, with respect to each:
  (i) The Preference Ratings, if any, assigned to such contracts or orders.
  (ii) The name and address of each customer.
  (iii) The kinds, quantities, and value of material covered by such contracts.
  (iv) The dates of actual deliveries thereunder.

"(f) Such suppliers shall, upon request, furnish to the Division of Priorities at any time, and from time to time, all or any part of the foregoing information and such other related information as may be required by the Division of Priorities for the administration of this or any subsequent order. Each supplier shall certify and furnish to the Division of Priorities on or before June 5, 1941, all information required by Form PD-29 (copy of which is attached hereto); and thereafter, not later than June 20, 1941, and not later than the twentieth (20th) day of each succeeding calendar month, each such supplier shall certify and furnish to the Division of Priorities such information as may be prescribed on forms which will be supplied for the purpose.

"(g) Such suppliers shall, from time to time, upon request of the Division of Priorities, submit to an audit and inspection

by its representatives with respect to any of the matter specified in paragraph (e) above."

Reports Required

In the course of the execution of the order each individual, firm, corporation or association in the United States which engages in the importation, sale, manufacture or processing of cork is required to file two reports with the Priorities Division, Office of Production Management, each month. The first is a request for processing and delivery allotments for the following month and must be filed on or before the 20th of each month. The other is a report of inventories, and actual processing and deliveries, and is due on or before the 10th of the month following the period covered.

The method of regulation is comparatively simple. The regulatory body receives the requests for allotments and after giving consideration to such factors as the available stocks of raw cork, the inventories of work in process and finished stocks, the seasonal trend of each class of product, and the relative competitive position of each supplier, establishes the amount of cork which may be used by each supplier in each class of product; the amount of equivalent cork content of partially processed material converted into final product; and the amount of equivalent cork content of deliveries to customers. These allotments thus have the weight of law and each supplier must keep within the quantities prescribed for each class of product. Then, on the 10th of the following month he reports his actual performance against these quotas.

While the method of regulation may be simple, the problems of the supplier in keeping within the established amounts and in keeping complete records so as to meet the requirements of the order and the regulatory body are more complicated. This is particularly true in the larger companies processing all types of raw cork and producing any product which may be made from cork or cork products.

Types of Cork

At this point it may be well to review briefly the origin and method of processing cork, so that the explanation of the record-keeping for OPM reports and regulations may be more intelligible.

Cork is the bark of a species of oak trees found only on the areas bordering on the western end of the Mediterranean Sea. Thus the major portion of the world supply of cork is secured from Portugal, Spain, Morocco, and Algeria, with negligible amounts being produced by France, Italy and several islands. Every seven to ten years the bark is stripped from the trunks of the trees. This bark is then boiled to remove resins and foreign matter, scraped to remove sand and other surface dirt, and sorted into grades to be shipped to the consuming centers of the world.

The commercial grades of cork bark are Virgin, Refugo, and Corkwood. Virgin cork is the first stripping of bark from the trees. This is suitable only for grinding to be used in cork insulation and similar products. Refugo is the lowest grade of bark secured from subsequent strippings. Much of it is used in the same class of products as is Virgin, but some of the best Refugo may be used for milling, that is, ground to finer particle sizes to be used for products such as composition cork gaskets. There are many grades of Corkwood, determined by both quality and thickness. Some of the poorer grades of Corkwood are used for milling purposes, but its principal use is in the production of bottle stoppers, marine goods and a host of other items known as "specialties."

The processing of Crokwood produces scrap which carries the commercial designation of "Waste." Again there are many grades and types of waste, depending upon the class and grade of prime products produced. Waste is generally a better quality than Refugo and is used for milling where a cleaner and more uniform grade of milled cork is desired. Since much Corkwood is processed abroad where there is little demand for waste, a considerable quantity of waste is also shipped to the United States.

Finally, there is another class of cork known as By-product. This consists of the dust from grinding and milling, ground cork with a high specific gravity, and scrap from the production of articles from composition cork. Since these By-products retain all the inherent qualities of cork, such as resilience and cellular structure, though to a lesser degree than fine grades, they have commercial value and are widely used. Thus, the cork industry surpasses the packing industry in that it wastes nothing, while the packing industry does not utilize the squeal.

The Industry

The larger firms of the cork industry enter all of its phases from the purchase of the bark in the forests, through its processing abroad and importation, to the ultimate usage of the last bit of by-product. They use every class of cork and produce all clsses of cork products. In contrast many small firms are engaged in single phases such as importation, manufacture only of bottle stoppers, cutting of gaskets from composition material purchased from others, etc. Between these two extremes are other firms engaged in varying degrees. Thus the regulation of the industry must be by types of raw material and also by classes of finished products. If this were not done the larger firms, covering the entire range of activities and product classes could gain an unfair competitive advantage over those with more limited supplies and markets. For example, let us assume cork stoppers were profitable while marine goods and specialties were not. The large processer could take advantage of this fact and use his entire allotment of Corkwood in the production of stoppers, and make no marine goods or specialties, thus maintaining normal production of this profitable item while his small competitor who produced only stoppers would have his business reduced in direct proportion to his allotment and thus tend to lose his position in the industry.

Therefore, the needs of each processor must be considered when the allotments are made. As a basis for determining relative needs the requests for allotments are prepared monthly, before the 20th of each month, on forms supplied by the Office of Production Management. The requests must be made for each kind of raw and by-product cork to be used for each class of products. Since the request for allotment follows the general form of the report of actual usage and deliveries, and to a degree is based on it, the report of "actuals" should be reviewed first.

Records Needed

Reports are presented for a company, rather than for each subsidiary, division, or factory of the company, so the first consideration in designing reports and records is that of consolidation within a limited time. Even if the general offices of the reporting firm are within overnight mail service to Washington they have only nine days in which each branch and factory must com-

pile its figures and forward them to the central office, and the central office must compile the final report. This simply does not allow time for correspondence with the factories and branches regarding their reports; the reports must be complete, accurate and intelligible when they reach the central office.

Also, since the order requires accurate and complete records (Section e) which are subject to audit (Section g) it is imperative that each factory and branch supplying data to the central office, and the central office, prepare proper original records and work papers which should be kept on file until the emergency is past and there is definite assurance that there will be no further audits. While this does not mean that a firm with a modern accounting system would have to change its normal procedure, it does mean that those which do not normally prepare monthly reports but operate largely from a cash box must make some radical changes.

Monthly Report of Inventories, Processing and Deliveries

The monthly report of "actuals" is composed of two schedules. The first shows, in pounds, the following for each kind of raw cork:

1. Owned stock in the U.S.A. on the first of the month.
2. Import receipts.
3. Purchases in U.S.A.
4. Own usage.
5. Deliveries to others.
6. Owned stock in the U.S.A. at the close of the month.
7. Owned stock afloat.
8. Stocks contracted for or owned abroad.

An inventory control system which provides a running record of all material from the purchase of each lot to its ultimate usage is all that is needed to prepare this part of the report. Due consideration must be given to material in transit between factories so as to be sure it is included but not counted twice.

The second lists the commodity classes produced from each type of raw cork or by-product cork and shows for each the equivalent cork weight of:

1. Opening inventory.
2. Raw cork usage.

3. Processed to final product.
4. Deliveries.
5. Closing inventory.

Converting to Raw Material Equivalent

The first problem encountered in compiling this report is the fact that inventories must be expressed in equivalent pounds of raw or by-product cork; that is, cork stoppers must be reported in terms of the pounds of Corkwood required to produce them, composition cork gaskets in terms of pounds of waste ground to produce the cork required to make the size sheet from which the gaskets were cut, etc. This is more difficult than expressing the weight of steel desks in terms of iron ore, or the weight of bacon in terms of pounds of hogs. Cork, like all natural products, varies greatly in its natural state, and the yield from any given lot will vary from the previous one. Also, the initial processing produces various grades of products from the same lot of raw cork, and one or more kinds of by-products. Thus it was found that while the standard material specifications represented averages that could be attained over a period of a year, they were not satisfactory for daily control nor for monthly reports. Other industries will be faced with these same conditions, for in most instances it is the raw material that is being controlled and therefore all inventories must be expressed in terms of the equivalent quantity of raw material.

The cork content of the inventories is calculated at standard and the total standard cork content for each class is then adjusted to the actual experience of the past three or six months. Such adjustment is based on a running average of yields and therefore the cork content is an approximate rather than an absolute figure.

Daily Control of Usage

A daily control of raw cork used is necessary in order to be sure that allotments are not exceeded. Two factors complicate this control: first, the initial processing of raw cork usually produces grades which will be used in more than one group of products; and second, cork in storage gains and loses moisture so that the weight accounted for in the usage reports is not the weight which was originally inventoried. In the first instance the raw

usage is allocated to products on the basis of their usage of prepared cork. Therefore, daily reports of such usage are also necessary. Moisture adjustments are made monthly on the basis of periodic tests, and the reported usage is held to an amount which when adjusted for moisture will not exceed the allotment. To a degree this procedure penalizes the processer in that it is not possible to use the full amount allotted, but from the periodic tests the general trend can be determined and the estimated required adjustment held very close to the final actual figure.

The "Process to Final" allotment regulates the use of semi-finished material which may be finally manufactured into one of several products. An example of this is composition cork mats which may be cut into gaskets or into insoles for shoes. Again daily reports of the use of such material are required. The cork content is calculated at standard and adjusted to average actual experience for the period.

The cork content of shipments is determined daily in the same manner as for process to final. Only shipments to trade are regulated and reported, thus movements of material to branches must be segregated, and shipments from branches must be added to direct shipments from factories to arrive at the total amount delivered to trade.

In all of these calculations only one figure is absolute, and that is raw cork usage. Therefore, opening inventories plus usage minus deliveries will not equal the calculated cork content of the closing inventory, since deliveries are based on average cork content rather than actual for the month. In order that the reported figures will balance, deliveries for the monthly report are secured by deduction, thus carrying through into deliveries the deviation of actual cork content for the month from the average actual used in daily reports. Deliveries deduced from opening inventory, usage and closing inventory should check closely with the total of the daily reports. Any material difference is considered in the following month in the adjustment from standard to actual cork content.

Request for Allotments

The request for allotments, submitted on the twentieth of each month shows the following:

I Inventory at close of previous month

II Estimated current month's actual
- a. Raw cork usage
- b. Process to final product
- c. Delivery

III Request for next month's allotment
- a. Raw cork usage
- b. Process to final product
- c. Shipments
  1. Defense
  2. Indeterminable
  3. Non-defense
  4. Total

The inventory at the close of the previous month is taken directly from the report of "actuals." The estimated current month's actual is secured from the daily reports of usage and deliveries to date of preparation of the request with an estimate for the remainder of the month based on the trends indicated.

Estimating Requirements

The request for next month's allotment requires an accurate description of the intended customers' use of material on all open orders in the files. It is essential for the sales organization to secure this information when they accept the order. This, in addition to the Priority Rating Certificates, permits the proper classification as to defense and non-defense, or indeterminable. This latter category would probably be used for orders from wholesalers and jobbers who may sell for defense and non-defense purposes. However, with their assistance on such orders it will be possible to estimate rather accurately the percentage of material which will ultimately be used for defense purposes. It may be possible that the open orders may not cover the total anticipated shipments of the month. In this event an estimate must be made, in the light of past experience, of the quantity and intended use of material to be ordered and shipped within the month.

This estimate of shipments will naturally influence the estimate of raw cork usage and processing to final. The record of inventories, yields, etc., required for preparing the report of actuals will

supply additional information for estimating these requirements. Where an intermediate, semi-finished inventory is necessary, the size of such reservoir desired and the seasonal trends which may call for its increase or reduction will determine whether or not the request for processing to final and of raw cork usage will be the same as for shipments.

Conclusion

There can be no question as to the fact that priority regulation greatly increases the amount of clerical effort at a time when production is probably reduced. However, since it is necessary for national defense it behooves every firm now regulated or facing regulation to study their order, inventory, receiving, usage and shipping records so as to secure the required information with a minimum of additional cost.

ESTABLISHING RELATIVE BURDEN RATES ON A MACHINE-HOUR BASIS

By Fred O. Kudert, Cost Accountant,
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THIS article deals with the information and the steps necessary to establish a machine burden rate in a job shop organization. Because the requirements will differ for each company, this paper is simply a description of how we arrived at our rates.

To make it easier for the reader to follow the line of reasoning it may be helpful to say a few words about our business. We are a medium-size concern, manufacturing a variety of decorated stampings and related products. Our orders vary from a thousand to several million pieces. Operations are rapid and numerous. The unit value of the equipment used ranges from a few dollars to several thousands of dollars. Formerly the equipment was assigned to departments and was seldom transferred from one department to another. One department used similar types of machines and performed one operation. Subsequent operations were performed in other departments. This meant that the product was trucked from one operation or department to another.

Revised Manufacturing Methods

With the advancement of manufacturing methods and the desire to improve quality and reduce costs, this arrangement gradually changed. Today machines of various kinds and sizes are frequently connected by conveyors. Where formerly a department was responsible for a few types of equipment and operations, it is now often responsible for all operations on a product. Instead of trucking the product, the equipment is moved. We try, of course, to schedule the work in such a way that machines remain connected and stationary for long periods of time. A department now operates many types and sizes of equipment. It is obvious that such changes would affect our accounting system.

Change to Machine-Hour Rates

It was decided to change our burden application method from a departmental direct-labor-dollar rate to a machine-hour rate, sim-

ply because there often was no labor on which to apply burden, yet expensive equipment was used to perform operations.

Machine burden rates may be established and used in more than one way:

1. As an inclusive single rate, absorbing all of the burden and all of the direct labor cost.
2. As an exclusive single rate, absorbing all of the burden, but with direct labor costs charged separately.
3. As a supplementary or "super" rate used in conjunction with another rate or rates, based upon direct labor hours or some other factor.

We decided to use a combined machine- and direct-labor-hour rate which will be fully explained later.

The purpose was to establish rates that would provide a charge to the product based on the extent the product benefited by the use of equipment. We also desired a record of the variable and fixed portion of each rate for a convenient breakdown of estimates into variable and fixed costs where such information was needed. Finally, we desired a convenient way to change rates without doing the whole job over again.

A machine burden rate may be established by dividing an estimated, normal or standard burden cost for a machine or group of machines by an estimated or normal standard number of machine hours. However, rates so established may still be out of line. An expensive machine, being used very little, would have a rate too high in proportion to other equipment. We wanted our rates to be correct as far as the relation of one type of equipment to another was concerned. How the foregoing purposes were accomplished is explained under the following headings:

1. Machine analysis
2. Tool analysis
3. Normal capacity
4. Normal burden
5. Average cost per hour
6. Basic information
7. Distribution ratios
8. Burden rates

Machine Analysis

Equipment was grouped by natural types and sizes. A separate group was established for each special machine when it was the only one of its kind. A list was made for each group, showing description, machine number, value and repair costs. Machine values were taken from a machine ledger. In analyzing the values for a group of like machines it was found that there were large variations. The reason for this was that some machines were purchased several years ago, some were acquired recently, while others had been motorized or otherwise improved or changed. Decision was made to place a value on each machine, based on the latest price paid for a particular type and size, providing that a machine was in good condition and served the same purpose as a new one. Other values had to be adjusted for other reasons.

The cost of motorizing, which had been accumulated on plant orders, was averaged for each type and size of equipment and added to the previously established value. The cost of other changes, when charged to expense, was estimated by our engineers and also added to the original value. The values for some special machines built in our plant were revised because they appeared to be out of line with the cost of similar equipment. This revaluation of equipment did not affect our ledger figures, but was done only for the purpose of establishing burden rates.

The values for each group were then summarized and an average value was established by dividing the total value for a group by the number of machines involved. Average values by groups were then analyzed by our engineering and production department. This brought out the fact that some types of machines were interchangeable. A regrouping became necessary and new average values had to be established for such groups. Thus some sixty different groups were reduced to forty-six groups at this stage of our work.

Tool Analysis

Most of the tools are made in our own plant and are identified by a serial number stamped on each part of a tool. Revisions and changes of parts for a tool carry a letter prefixed to the origi-

nal number. An individual record is kept for each tool, giving description and costs.

The problem was to establish an average tool value for each machine group previously established. Current manufacturing specifications were used to provide the information needed. For easy handling and filing a 2" x 3" card was used to which the required information was posted. Tool numbers were posted in the upper lefthand corner, and the types or numbers of the machines on which these tools would be used in the upper righthand corner. Some tools and operations are the same for many products, which meant there were duplicate cards. The duplicates were easily eliminated after the cards were filed numerically by tool numbers. Tool costs were next taken from the tool record and posted in the lower lefthand corner of the cards. Tool repair costs, which were accumulated by tools, were posted in the lower righthand corner. The cards were then sorted by machine groups and listed, showing tool numbers, original cost and repair costs. Tools and costs were analyzed and corrections were made before costs were summarized and average values established for a machine group.

Normal Capacity

It is a difficult problem to ascertain normal capacity. Among the questions that arise are the following:

1. Shall the normal be based on capacity to sell or capacity to manufacture?
2. Shall the normal be set for each department with particular regard to the capacity of related departments, or shall the normal be set for each department without regard to other departments?

In the final analysis, management policy may answer most of the questions involved. Before management makes its decision, however, it is well to have available certain information based on past experience.

We tabulated our experience for the years 1938 and 1939, as shown in Exhibit 1. The direct production hours for each indi-

EXHIBIT 1

NORMAL CAPACITY

Group	No. of Mach.	Theoretical Capacity	Machine Hours 1938	Machine Hours 1939	Per Cent of Theoretical Capacity 1938	Per Cent of Theoretical Capacity 1939
1	10	20,000	27,000	24,000	135	120
2	41	82,000	18,900	32,800	23	25
3	2	4,000	2,000	400	50	10
4	1	2,000	1,800	2,800	90	140
5	46	92,000	45,300	30,000	49	32
Total	100	200,000	95,000	90,000	48	45
Allowance:						
For set-up	10%	.....	9,500	9,000	..	..
For delays, etc.	25%	.....	23,750	22,500	..	..
Grand Total		200,000	128,250	121,500	64	61

NORMAL HOURS

Description	*Hours*
Machine Hours	90,000
Set-up Hours	9,000
Total Machine Hours	99,000
Pay Roll Hours (145%)	143,550
Total Burden Hours	242,550

vidual machine are accumulated daily as part of our routine work, and are summarized at the end of the year. The problem was quite simple; all we had to do was to summarize these hours by machine groups that we had previously established. The theoretical capacity per machine was set at 2,000 hours per year. It now was merely a matter of mathematics to figure the per cent of theoretical capacity for each group of machines.

An allowance of 35 per cent of actual machine hours was added to the total machine hours. This allowance, providing 10 per cent for set-up (a burden element with us), and 25 per cent for repairs and other delays, had been used by our production department for some time, and had been checked on several occasions. The reason for adding this allowance to the total rather than distributing it to machine groups, is that any distribution would have had to be based on guesswork. An accurate distribution would be possible only in a case where set-up and lost machine time are accumulated by machines or groups.

The total actual hours plus the 35 per cent allowance, divided by the total theoretical capacity hours, gives us a capacity per cent. An analysis of capacity by groups, which was, of course, without allowance, indicated that some machines had been operated at 140 per cent of capacity while others were utilized at only 10 per cent of capacity. This was no surprise and must be expected in this type of organization. Operation at 140 per cent is due to more than one shift while operation at 10 per cent is due to lack of orders for a particular kind of work.

After giving due consideration to sales over a period of years, it was management's opinion that machine hours for the year 1939 represented as near a normal as we were able to establish, and that this experience should be used as the base for calculating burden rates. This meant that we would choose capacity to sell as normal capacity and that the normal for each group would be set in relation to other groups of equipment, based on past experience.

Normal Burden

Normal burden is comparatively easy to ascertain once the question of normal capacity has been answered. Burden, as we know it, consists of fixed and variable items of expense. Our fixed burden consists of shop salaries, depreciation, insurance, taxes, etc. For each of these accounts we used current amounts, adjusted by anticipated changes where such could be definitely foreseen.

Variable expenses consist of functional expense (production service), defective work, water, gas and electricity, equipment expense (building of tools and other equipment), and equipment maintenance. For many years these costs have been figured by accountants per machine hour, and in considerable detail. Costs are figured per machine hour by departments for such items as idle time, trucking, machine and tool repairs, etc. These detailed costs per machine hour are also used as the basis for our shop expense budget.

A standard rate per machine hour, based on past experience, was now set for each variable expense account. These standards, multiplied by the normal capacity hours as previously explained, gave a normal variable expense for each account. This is illustrated in Exhibit 2.

EXHIBIT 2

NORMAL BURDEN BY ACCOUNTS

Account	Description	Standard	Amount
1	Salaries		8,000
2	Depreciation		15,000
3	Insurance		1,800
4	Taxes		7,200
5	Vacations		5,000
6	Private Pay Roll		15,000
Total Fixed			52,000
7	Functional Expense	.50	45,000
8	Defective Work	.05	4,500
9	Water, Gas, Electricity	.04	3,600
10	Equipment Expense	.15	13,500
11	Equipment Maintenance	.06	5,400
Total Variable		.80	72,000
Total Normal Burden			124,000

Note: Variable amounts are standards per hour times normal hours.

Average Costs per Hour

Distribution of actual burden to departments is made on the basis of area, number of employees, service, and so forth. Exhibit 3 illustrates how we have established over-all average costs per hour. Amounts for items 1 to 9 inclusive are the cost of the department that can be directly distributed to machines or machine

EXHIBIT 3

AVERAGE COST PER HOUR

Item	Description	Total Amount	Burden Hours	Per Hour
1	Depreciation and Taxes on			
2	Equipment	4,200	99,000	.04242
3	Machine Area	7,000	99,000	.07071
4	Total Fixed	11,200	99,000	
5	Machine Repairs	3,800	99,000	.03838
6	Tool Repairs	12,000	99,000	.12121
7	New Tools	8,000	99,000	.08081
8	Electric Power	1,200	99,000	.01212
9	Total Variable	25,000	99,000	
Total Direct Machine Cost		36,200	99,000	.3657
10	Balance—Fixed Cost	40,800	242,550	.16821
11	Variable Cost	47,000	242,550	.19377
	Total Cost	124,000		(.36)

groups. Area cost—Item 3—represents a building cost per square foot, times the number of square feet occupied by machines. Machine areas here do not include aisles, washrooms, and so forth. Normal hours—99,000—have been used as shown on Exhibit I. The set-up hours amounting to 9,000 are included, because set-up costs will be absorbed at the same burden rates as production.

Items 10 and 11 are other fixed and variable costs at normal capacity, taken from Exhibit 2. These items are divided by 242,550 hours as established on Exhibit 1. The ratio of payroll hours to total machine hours—145 per cent—approximates our experience. The reason for adding payroll hours to machine hours, is our desire to spread the remaining burden over machine and direct payroll hours alike. There are very few hand operations, and many machines are used without operators. Therefore, we could not spread the balance of our burden over direct labor hours only. It was also reasoned that the remaining balance of burden existed as much by our ownership of equipment as by the employment of labor.

Basic Information

Exhibit 4 is a summary of basic information needed to establish distribution ratios. Machine groups and average values for machines and tools have been discussed previously.

EXHIBIT 4

BASIS INFORMATION

Group	*No. of Mach.*	*Average Value Mach.*	*Tools*	*Repair Factor Mach.*	*Tools*	*Area Sq. Ft.*	*Power Factor*
1	10	150	100	5	10	42	50
2	41	1,500	200	6	12	56	60
3	2	3,600	700	15	20	72	75
4	1	2,000	3,500	10	30	108	100
5	46	600	350	7	15	90	70
Over-all Average		998	302	6.58	13.52	71	64.3

Repair factors for machines and tools are estimates made by our engineers, superintendent and foremen. If a repair factor for one machine group is 10 and for another 20, the latter should carry a repair burden rate twice the amount of the former. Actual repair costs, which were available by machines and tools and had been summarized by machine groups, were helpful in checking the estimated factors. Actual repair costs per machine hour were not used because the actual costs per hour for pieces of equipment

were felt to be incorrect, due to a short period of experience or accidents. Let us assume that our experience with an inexpensive machine indicated a very high repair cost as against a very complicated and expensive mechanism with a very low repair cost. Such experiences should not be used for establishing rates. We must always bear in mind that final burden rates are going to be part of a basis that establishes a selling price.

Area, expressed in square feet, represents the area needed for a type of equipment. Power factors were established in a manner similar to that used for the repair factors.

Distribution Ratios

Having established the foregoing basic information, it is a simple matter to figure distribution ratios. The value, area or factor of a machine group, multiplied by the number of machines in a group, equals a total. The addition of totals divided by the total number of machines equals the over-all average value, area or factor. The average value, area or factor of a group is now divided by the over-all average (100 per cent) and the result is our distribution ratio. This calculation for the tool repair factor is shown in Exhibit 5. A complete set of ratios is shown in Exhibit 6. To state

EXHIBIT 5

CALCULATION OF DISTRIBUTION RATIOS ILLUSTRATED

Group	*Number of Machines* (1)	*Tool Repair Factor* (2)	*Total* (3) (1 × 2)	*Average Factor of Group* (4) (2 ÷ 5 × 100)
1	10	10	100	74
2	41	12	492	89
3	2	20	40	150
4	1	30	30	222
5	46	15	690	111
Totals	100		1,352	
Over-all average	(1,352 ÷ 100)		13.52 (5)	

EXHIBIT 6

DISTRIBUTION RATIOS

Group	*Depreciation & Taxes*	*Area*	*Machine Repair*	*Tool Repair*	*New Tools*	*Power*
1	15	59	76	74	33	78
2	150	79	91	89	66	93
3	360	101	228	150	232	117
4	200	152	152	222	1,159	156
5	60	127	106	111	116	109

this in simple terms—a distribution ratio is the relation of a machine to the over-all average.

We believe that these ratios will be fairly stable for a long period of time. Additions and changes in equipment will, of course, disturb this relation, but not to an extent that would seriously affect a burden rate under normal conditions. These ratios will enable us to refigure one element of cost at a time, without recalculating all elements of the burden.

Burden Rates

We are now ready to figure burden rates as illustrated in Exhibit 7. We take the over-all average cost per hour for an item

EXHIBIT 7

BURDEN RATES

Group	Depr. & Taxes	Area	Repair Mach.	Repair Tool	New Tools	Power	Total
1	.0064	.0417	.0292	.0897	.0267	.0095	.2032
2	.0636	.0559	.0349	.1079	.0533	.0113	.3269
3	.1527	.0714	.0875	.1818	.1875	.0142	.6951
4	.0848	.1075	.0583	.2691	.9366	.0189	1.4752
5	.0255	.0898	.0407	.1345	.0937	.0132	.3974
Over-all Average ..	.04242	.07071	.03838	.12121	.08081	.01212	.3657

RATE TEST

Group	Normal Hours	Rate	Amount
1	24,000	.2032	4,877
2	32,800	.3269	10,722
3	400	.6951	278
4	2,800	1.4752	4,131
5	30,000	.3974	11,922
Total	90,000		31,930
Set-up Hours	9,000	.3657	3,291
Grand Total	99,000		35,221

RATE SUMMARY

Group	Description	Machine Rate Fixed	Machine Rate Variable	Machine Rate Total	Machine and Employee Rate Fixed	Machine and Employee Rate Variable	Machine and Employee Rate Total
1	Mach. Rate	.22	.34	.56	.39	.53	.92
2	Mach. Rate	.29	.40	.69	.46	.59	1.05
3	Mach. Rate	.39	.67	1.06	.56	.86	1.42
4	Mach. Rate	.36	1.48	1.84	.53	1.67	2.20
5	Mach. Rate	.28	.48	.76	.45	.67	1.12
6	Empl. Rate	..	..	..	.17	.19	.36

as shown in the last column of Exhibit 3 and multiply it by the distribution ratio shown on Exhibit 6. The result is the relative burden cost per hour for a particular machine or group of machines. The summary of the six columns gives us the total machine rate.

The rate test on Exhibit 7 indicates that these rates would absorb $35,221 of the $36,200 shown on Exhibit 3. This is a few per cent short of our goal and corresponds to our experience on actual rates. The reason for this shortage is the many averages that we have to establish. This may be easily overcome by increasing each rate by a small fraction.

At this point there had been actually established forty-six machine rates. With a relisting of our groups numerically by rates and analyzing the result, we found these forty-six rates could be reduced to eight rates without having a single one out of line by more than six cents, or three cents on the average. For practical reasons decision was made for eight machine rates.

The rate summary on Exhibit 7 shows two types of rates, each broken down into its variable and fixed elements for each one of the groups. It will be noted that one more group has been added in our illustration. This group, indicated as an employee rate of $.36, is the burden rate for direct labor hours and is obtained by combining the last two items in the last column of Exhibit 3. The total machine rate is the total rate for a group as shown plus $.36, which is the average rate for the burden not distributed by machines, as previously explained.

The fixed portion of the machine rate in group 1 is $.0064 (depreciation and taxes) plus $.0417 (area) plus $.17 (employee rate), which equals a total of $.22 as shown in the rate summary. The total machine rate is $.2032 plus $.36 (total employee rate), or a total of $.56 as shown in the illustration. The variable portion is the difference between $.56 and $.22, or $.34 per hour.

To the machine rate there is added once more the over-all rate of $.36, thus arriving at a combined machine hour and direct labor hour rate. The reason for developing two rates for each group—a machine rate and a combined rate—is that some machines are used without labor. In actual application we use eight combined rates and three machine rates, or a total of eleven rates. A list by machine numbers which shows the rate group number makes application simple.

Application

To illustrate the use of these rates further, let us assume that two people work on a job consisting of four operations and four machines coupled together as one unit. Let us also assume that one operator feeds the first machine and the other operator packs the product following the last machine operation. Time tickets would be made out as follows: The first time ticket is made out for the operator feeding the first machine. This will show the operator's clock number and the machine number, besides all other required information. For the following three machines three time tickets are made out, each one showing the machine number, but no clock number. These tickets are stamped "M.H." indicating to the payroll and cost departments that these hours are for machines without labor. Another time ticket is made out for the packer without a machine number. We could have combined this operator on the time ticket for the last machine and thereby have saved one ticket, but as a record is wanted of machine hours without labor, this method seems more positive.

The burden rates for this illustration would be as follows: The first time ticket would be a machine and employee rate, the next three would be machine rates only, and the last one would be an employee burden rate only.

Summary

Let us now briefly review our work. Equipment of like or similar kind has been grouped and standard values established for each machine. The experience of 1939 was considered as representing normal capacity. Fixed burden was established by accounts at present costs, projected for the future, where possible. A standard per hour and account, based on past experience, times normal capacity hours established a normal variable burden. The direct machine burden by elements, divided by normal machine hours, gave an average cost per machine hour. This average cost per machine hour was distributed over all machines to the extent that a machine was related to the over-all average. Burden in excess of the amount distributed directly to machines was distributed equally over all machine and direct labor hours.